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How to Control . . . . Weeds and Algae in Farm Ponds

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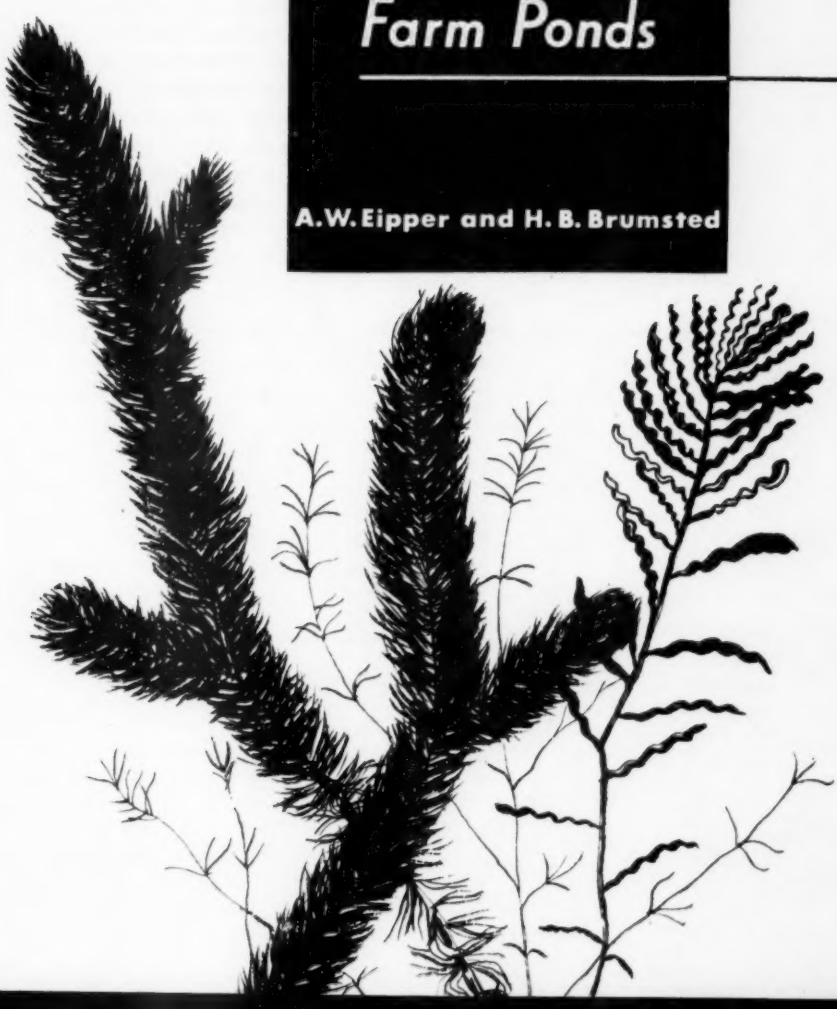

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How to Control Weeds and Algae in Farm Ponds

A. W. Eipper and H. B. Brumsted

Since the late 1940's, increasing numbers of farm ponds have been built in New York State. These small, man-made impoundments serve as a source of water for livestock, fire protection, crop spraying and irrigation, and ponds are now regarded as an important and useful type of farm water supply. Farm families and other rural residents have found them to be excellent sources of year-round recreation—fishing, swimming and ice skating. Raising minnows or crayfish for sale as fish bait, and operating a fishing preserve, represent opportunities which can return cash income to the pond owner.

The usefulness and value of a farm pond for any of these purposes can be greatly reduced by growths of plant life which, in some form, will develop in every pond. This publication describes the types of plants that commonly invade ponds, the problems they may cause, and preventive or control measures.

Farm ponds may be defined as small bodies of water made by excavating a basin or building a crescent-shaped earthen dam on a slope, which are one-tenth to five acres in surface area and have maximum depths of 7 to 15 feet. The Division of Fish and Game of the New York State Conservation Department helps landowners develop another type of man-made impoundment known as *wildlife marshes, farm marshes,* or *wildlife ponds.* They are purposely designed and built with shallow depths averaging one to two feet *to encourage* the aquatic plant growth vital to waterfowl and other wildlife as shelter and food. Where water plants are interfering with the use of a wildlife marsh, the State Conservation Department district game manager should be contacted for advice.

Owners of property along lakes or other public waters with aquatic weed problems may find this bulletin helpful in understanding local situations and by providing suggestions for mechanical control of weeds.

Chemical control of weeds in all waters of New York State is now regulated by the State Health Department. See Legal Responsibilities, page 31.

Figure 1. With weed control, this half-acre pond provides year-round fire protection and stock water, plus trout fishing and swimming in summer and skating in winter.

Pond Plants and How They Live

The plants found in farm ponds represent two main groups:

Algae

These primitive plants lack the true roots, leaves, and flowers characteristic of familiar plant life. Like higher plants, algae contain chlorophyll and manufacture food by photosynthesis. The most familiar algae are the filamentous types which exist as long, hairlike strands and form thick greenish or yellowish-green mats on the water surface. Their growths are often called "pond scum" or "frog spittle." Microscopic examination of common mat-forming algae would reveal that some kinds have branched strands. An interesting but infrequently found type grows in the form of a delicate netlike mesh. It is called water net and can be identified with the naked eye (figure 2).

Other algae common in ponds occur as millions of tiny cells, or small clusters of cells, scattered throughout the water. When these are abundant they give the water a soupy greenish or brownish appearance often called a "water bloom." These bloom-forming, or plankton algae, are important in nature, because they serve as the basis for animal life in fresh and sea water.

Another group of algae appear to

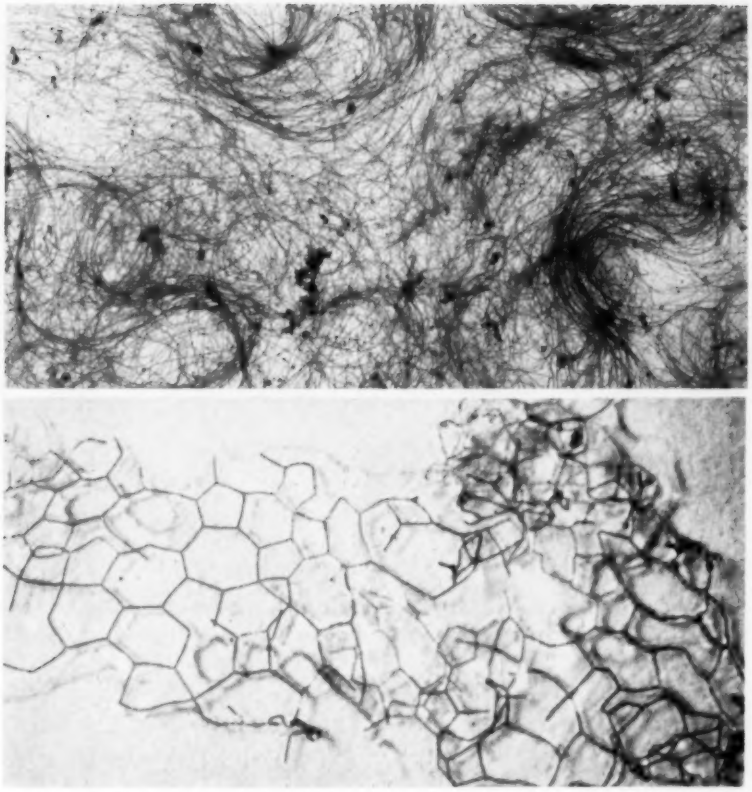

Figure 2. Filamentous algae (pond scums) are composed of many long hairlike strands, as shown in upper photograph. Waternet (below, enlarged) is a special type composed of tiny "meshes" up to ⅛ inch across.

be rooted in the bottom and to possess whorls of leaves on an erect stem. They are called muskgrass or stonewort and are easily identified (figure 5). In limestone regions, a thin crust of lime forms over them making their parts rough to the touch and they have a very characteristic musk or skunk-like smell. Growths of muskgrass up to two or three feet high may entirely cover a pond bottom.

Algae reproduce by minute spores which are resistant to drying and other adverse conditions and are scattered widely by wind. In this way algae are introduced continuously to farm ponds.

Figure 3. Emergent plants common in shallow areas of farm ponds are cattails, rushes, sedges, and water plaintain.

Higher Plants

These are plants that have roots, leaves, flowers, and reproduce by seeds. Many plant families best known as land dwellers have members which live in water.

The several different locations where water plants are found growing in a pond provide a useful way of grouping and referring to them:

Emergent plants. Shallow water to depths of three to four feet may be occupied by plants which are rooted in the bottom but have leaves and stems which come up *above* the water surface (figure 3). The group includes rushes, sedges, and reeds, with cattails perhaps the most common species. Cattail seeds are wind-borne so this plant may be one of the first to appear. Most sedges and rushes have small, light seeds easily brought to a pond on the feet of birds.

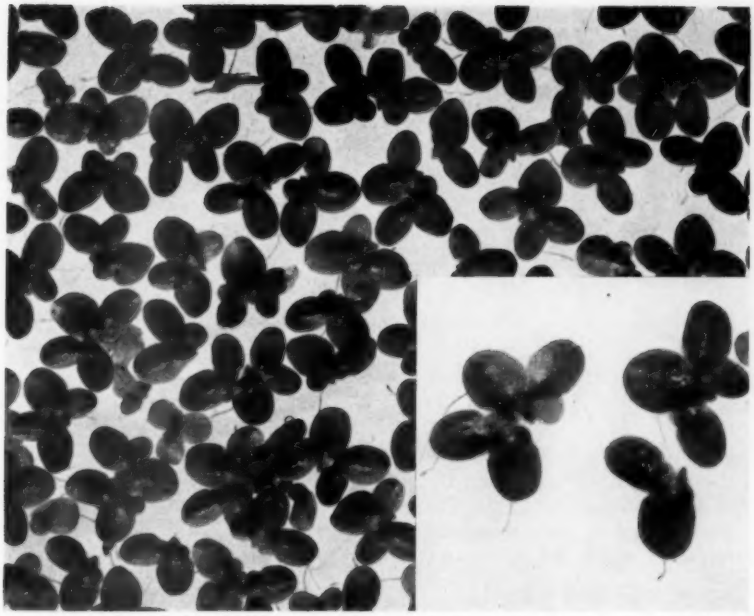

Figure 4. Duckweed is a tiny floating plant not rooted in the pond bottom. Individual leaves (inset) are about $^1/_{16}$ to $^1/_4$ inch across.

Floating plants. The water surface is another zone that pond plants occupy. Water-lilies are perhaps the most familiar example, but they are rarely found in farm ponds except where introduced by the owner. More typical are duckweeds which appear as very small oval or round floating leaves with several lobes or sections (figure 4). One or more fine roots an inch or two long grow down from each section of the leaf but they are not attached to the pond bottom; the plants are entirely free-floating.

These are true flowering plants but they typically reproduce rapidly by budding off new plants. Where a pond is well sheltered from wind, duckweed may blanket the entire water surface. Birds likely serve to spread duckweed by bringing in entire plants.

Submersed plants. Underwater plants are rooted in the bottom and grow up to the water surface. Since their parts are not exposed to air, most possess finely-divided or ribbonlike leaves for absorbing gases dissolved in the water. Submerged plants are often called "seaweed" or "grass." There are many kinds:

Figure 5. Several common submersed aquatic plants. From left to right: muskgrass, naiad, water milfoil, and waterweed (Elodea). Muskgrass is an alga resembling higher plants.

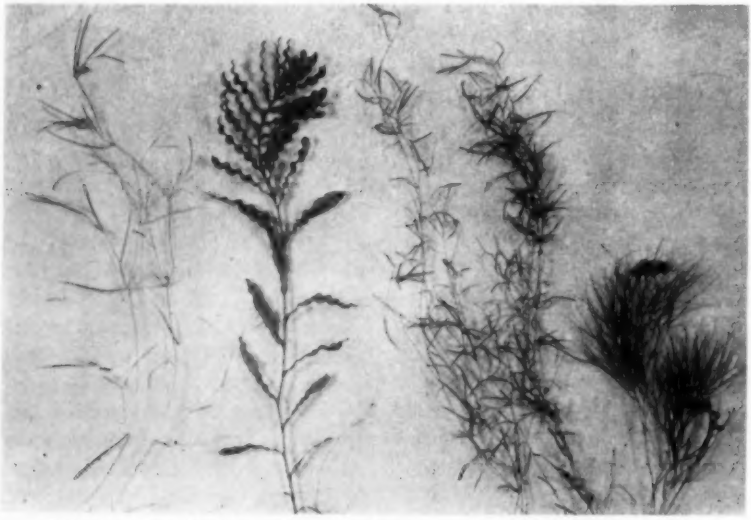

Figure 6. Four kinds of submersed plants all referred to as "pond weed."

waterweed, water milfoil, naiad, and pondweed are just a few of the more common ones (figures 5 and 6). In clear water ponds, submersed plants may be present throughout. Seeds of these plants are relatively large. They are mainly introduced through droppings of waterfowl. Usually they appear two or three years after a pond has filled.

Although algae or higher plants invade a pond, they may not become established and some forms may never succeed. Heavy growths of higher plants are not usually found until three or more years; in many New York ponds, now five to ten years old, they still have not developed.

The distinction between these three groups of higher plants—emergent, floating, and submersed—is important and the terms will be used throughout the bulletin.

Place of Weed Control in Pond Management

Some farm pond owners think that their ponds should be kept completely free of all plant growths. There is generally a definite advantage in controlling the amount of some plant life, but complete eradication of all forms is rarely necessary or practical.

Beneficial Effects of Weeds

In farm ponds, as in all waters, the microscopic, bloom-forming algae are important food for tiny animals which, in turn, may be eaten by fishes. High yields from bass-bluegill ponds and bait ponds require a heavy growth of these algae. Ponds used for growing bait minnows and other warm water fish are usually fertilized to encourage algae growth.

Even filamentous algae and higher plants (especially submerged forms) increase fish production, particularly in trout ponds. They sometimes aid trout survival by keeping the water cool by shading. These plants may also improve trout growth by increasing the population of water insects, the chief food of farm pond trout.

In ponds used to raise bait minnows that lay their eggs on vegetation, small amounts of these plants are necessary for good minnow reproduction unless artificial spawning devices are used.

Aquatic plants are interesting forms of vegetation. They help to make a pond look natural and attractive to more varied groups of wildlife.[1]

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[1]More information about the natural history of aquatic plants will be found in:
Field Book of Ponds and Streams. By Ann H. Morgan. G. P. Putnam's Sons. New York City. 1930.
Pond Plants. By H. B. Brumsted. N. Y. S. Conservationist, August–September, 1956. (Limited supply of reprints available from N. Y. S. Conservation Dept., Albany 1, N.Y.)

Harmful Effects of Weeds

Plants are often serious obstacles to farm pond management. They may clog overflow structures, stock water pipes, and intakes to irrigation systems and fire pumps; they can make fishing, swimming, and bait-minnow harvest difficult or impossible.

In ponds stocked with bass and bluegills, plant growth may provide so much shelter for bluegills that not enough of them are eaten by the bass. This commonly leads to an overpopulation of bluegills, accompanied by poor fish production and fishing.

The decay of heavy amounts of vegetation uses oxygen. In addition, during cloudy weather, or under prolonged ice and snow cover, living plants use more oxygen than they produce. The combination of these circumstances can lead to an oxygen shortage resulting in a fish kill.

Some of the single-celled algae give pond water an objectionable odor or taste, and a few kinds produce poisons which can kill fish, birds, and livestock. Fortunately, these latter cases are rare in the Northeast and usually are preventable, since they result from barnyard drainage.

If pond water is used in a home laundry, heavy water blooms may give a greenish color to fabrics.

No exact rules can be made about how much plant growth is right for a certain pond. Each owner must make his own decision on this, considering both the good and bad effects of weeds in relation to the most important pond uses.

Principles of Water-Weed Control

There is no practical, permanent way to prevent water plants from invading a farm pond. However, steps can be taken in the construction and management of a pond to *delay* development of heavy plant growths which cause problems. When troublesome amounts of weeds appear, there are measures for *temporarily eliminating* them.

Delaying Weed Growths

Pond scums and higher plants start their development on the pond bottom. Like other green plants, they need adequate light. Aquatic vegetation prospers in shallow, clear water, so problem growths can be delayed by cutting down the amount of sunlight reaching the bottom.

Proper pond construction. The sides of the pond should slope sharply so that as little of the pond as possible has a water depth of less than three feet. A slope of 3:1 is advisable, that is, making a one foot change in elevation for three feet of horizontal distance. Such slopes

Figure 7. Weed problems are less if all sides of the pond are steeply sloped.

can be made by a bulldozer (figure 7). This 3:1 slope should extend at least 10 feet out from the shoreline toward the center of the pond and farther if possible.

Many ponds have a side or corner which soon became choked with weeds because the water was too shallow. In most of these cases, the owner regrets not having made an additional investment at the time of construction to obtain deeper water along the entire pond margin.

If runoff waters bring heavy loads of silt into a pond causing it to fill rapidly, weed growths will probably increase as the water becomes shallower. Such situations are rare in well-engineered farm ponds, but there are many small bodies of water in the State where rapid silting has occurred, causing serious weed problems. Draining the pond and excavating portions of the bottom will improve the condition for a few years. This may be expensive. Sometimes the silt can be trapped by low dams built in the stream feeding the pond. If this is possible, the effects of excavation last longer. Consult your local Soil Conservation Service technician or other qualified person for advice on this and other construction problems.

Fertilization. A second way to delay weed growths is by fertilizing the pond. The object is to produce a heavy bloom of microscopic algae that will reduce the amount of light reaching the pond bottom, making

Figure 8. Checking to determine fertilizer requirements. When the bloom is this heavy, the pond need not be fertilized.

conditions there less favorable for development of scums and weeds.[2] Ordinary inorganic fertilizers such as are commonly applied on field crops, lawns, and gardens are used. Under New York conditions, the proportion of the three major elements which these fertilizers contain—nitrogen, phosphorus, and potassium—has not been found to be important, but the fertilizer should contain some of each one. Any complete fertilizer such as 5–10–5 or 10–10–10, should prove satisfactory.

The amount of fertilizer needed may be about 1,000 pounds per acre of pond surface per year, but ponds vary greatly in fertilizer requirements. Fertilization should be started as soon as the pond is free of ice in early spring, and be discontinued about mid-September. During this period you should check the condition of the bloom frequently, applying fertilizer when the water begins to clear. To make this determination, put one arm straight down into the water to elbow depth; if your fingers are visible, the pond needs fertilizer (figure 8).

Fertilizer can be broadcast over the pond surface. A simpler and more effective method is to cut the

[2]Some swimmers feel that a "bloom" makes the pond water less attractive, and some owners of ponds used primarily for swimming may wish to avoid fertilizing for this reason.

side out of the fertilizer bag, and place it (open side up) in one or two feet of water along a shore exposed to inflowing water or to wave action. The fertilizer will go into solution and water movement will distribute it throughout the pond. Use one 80-pound bag of fertilizer per application in ponds of one-half acre or less. In ponds over half an acre, use two bags at a time.

Note these points carefully:

1. Fertilizing is *not recommended* for trout ponds, because fish kills have been associated with its use.

2. *Eliminate* growths of algae and higher plants (preferably by chemical means) *before* fertilizing. If this is not done, these plants will take up the nutrients and the result will be more weeds instead of a bloom. Use a rake, loop of barbed wire, or some sort of grappling hook attached to a line to check for the presence of scum or weeds on the pond bottom.

3. Check your pond frequently from early spring through late summer, adding fertilizer whenever necessary. Fertilizing only once or twice when you happen to think of it may increase weed growth, doing more harm than good.

4. Results of fertilizing are variable. For reasons that are not completely understood, some ponds fail to produce a bloom at times.

Eliminating Weeds Already Present

The principal ways of removing pond plants fall in two categories, *mechanical* and *chemical*. Before discussing these in detail, it should be mentioned that the widespread belief that domestic ducks are useful in controlling water plants, particularly scums, has not been proved. In tests conducted in New York ponds, scums were not controlled. The presence of ducks on small ponds can be objectionable, for they foul the bank and water, reducing the value of the site for recreation; also certain kinds such as muscovies, may prey on fish.

Mechanical Control. This method includes cutting, pulling, or dragging the plants, or parts of them, from the water. Mechanical controls are often useful where spot removal or thinning of weeds is desired, where it is desirable to remove the bulk of a heavy growth before applying chemical treatment, and where chemical control is prohibited or not feasible. The few mechanical methods described here have general application in farm ponds.

Cattails, the emergents most likely to be troublesome, are perennials. Once established, they may spread rapidly in shallow water by thick rootstocks called rhizomes. As seedlings, cattails are easily pulled by hand, so it is best to keep them under control as they appear. Later, after rhizomes have developed, it becomes more difficult. However, pulling them is by no means impossible, especially if it is begun in deep water, at the ends of the

rhizomes, and continued in toward shore. Several boys can eliminate a considerable area of cattail in a few minutes. If growths are extensive, cutting may prove more practical, but it must be repeated several times during the growing season to control the plants.

Duckweed forms a blanket of free-floating plants that often can be removed by raking or dragging it from the pond surface. This is most readily done when it has been concentrated along one side of the pond by wind. Otherwise, a buoyed rope or a floating boom made of poles or boards fastened together can be used to drag the plants near shore where they can be raked out.

Pond scums are controlled according to their stage of growth. If the masses of scum are mostly submerged, they may be successfully dragged out with a long piece of weighted barbed wire. When the scum is present as a floating mat, drag and rake as described for duckweed.

Submersed plants are often so tough and firmly rooted that they cannot be successfully removed by mechanical means. However, barbed wire can be used to drag out the kinds with thin, light stems. This method also may prove successful with stoneworts, the algae with rough texture and skunky odor. Weed cutters, although sometimes used to clear submersed aquatics from boat channels in lakes, are not considered practical for farm pond use.

Chemical Control. Chemical weed killers are applied either to the pond water or with emergent and floating plants, directly on the vegetation. Chemical herbicides are being developed at a rapid rate. Those discussed here are chemicals which, as of January, 1958, have proved most effective under New York conditions without endangering fish.

The remainder of this bulletin is devoted to details of chemical control.

General Aspects of Chemical Control

Effectiveness

Like the methods of pond weed control already discussed, the results of chemical treatment will be only temporary. Occasionally, a single application will be sufficient for an entire season, but commonly two or more may be required. Chemicals should never be used as a preventive measure. They should only be employed *after* weeds have appeared.

Many factors can influence the success of chemical weed control, the more important being (1) kind, amount and stage of development of vegetation to be destroyed, (2) water temperature, (3) water hard-

Figure 9. It is essential to follow directions and apply only the recommended amount of chemical.

ness, and (4) amount of water flowing through the pond.

Algae and many weeds are most easily and effectively controlled with chemicals if treatment is made soon after growth has started. Not only is the quantity of vegetation smaller then, but the plants are more susceptible to chemicals in early stages of growth.

Some chemicals are less effective when the water temperature is below 60° F. For this reason, chemical treatment in early spring and after mid-September should be avoided. Late fall treatment is undesirable also because plants decaying after ice formation may deplete the oxygen supply.

If weed growth is especially heavy, the recommended chemical treatment may not kill all the plants. The same amount of chemical (but never more) can be applied again after two weeks. Removing the bulk of heavy growths by mechanical means before using chemicals not only increases the chances for thorough chemical control, but lessens the danger of bringing on an oxygen shortage that could result from too much plant material decaying at one time.

Since most ponds are fed by runoff water or low-volume springs, they usually do not overflow during the growing season except after heavy rain. Where a stream flows

through the pond, however, chemicals added to the water may become so dilute that they are not effective. In this situation treatment may be repeated after two weeks with one and a half times the standard recommended amount of chemical. Special caution is urged, for pond owners may be liable if the chemicals flow into other waters and cause damage. See Legal Responsibilities, page 31.

Precautions

When treating pond water with chemicals it is necessary to follow directions carefully. Use only the recommended amount of chemical and apply it in the prescribed manner. Overdosage or careless handling can destroy all fish and other pond animals and endanger humans, livestock and plants coming in contact with the water.

Careful handling means the following:

1. Apply *all* the chemical on the pond or on the vegetation you desire to kill. If spraying, avoid any drift onto land plants near the pond. Do the job when the air is calm, use a moderately coarse spray, and keep the spray nozzle fairly close to the water.

2. Keep chemicals out of mouth, nose, eyes and off skin. Wash accidental contacts promptly. Special caution is urged in using sodium arsenite, *a dangerous poison.* When

Figure 10. A heavy growth of filamentous algae. Here it would be best to treat only half the pond at one time.

using it wear rubber gloves and never spray into the wind.

3. Keep containers of chemicals away from children and animals.

After chemical treatment, wait one week before using the pond for swimming, watering livestock, or irrigation.

Do not permit livestock to graze vegetation around the margin of a treated pond until after a heavy rain.

Ornamental trees and shrubs growing near the pond may have roots in contact with the water. All the chemicals except copper sulfate may be harmful to these plants if applied to the pond water.

All parts of spray equipment used for applying chemicals should be washed with a detergent and rinsed thoroughly after each use. Latest information indicates that, for absolute safety, a sprayer that has been used for 2,4–D should *never* be used for applying insecticides, fungicides, etc. to valued plants, *regardless* of how well the sprayer has been cleaned.

If weed growths are heavy, the danger of producing an oxygen shortage and fish kill by killing all the vegetation at once can be minimized by treating only half the pond at one time. If this is done, *use only half as much chemical* as needed for the whole pond, and *wait two weeks* before treating the second half. A pond where this procedure should be followed is shown in figure 10.

Figure 11. Portable tank sprayers are useful for pond weed control.

Equipment

The chemicals described here are most easily applied with a portable tank sprayer, such as the 3½-gallon type commonly sold for garden use (figure 11). Apply solutions evenly over the area of water or vegetation to be treated, and agitate the tank occasionally to maintain the mixture while spraying.

How To Use the Chemicals

This section will describe the chemical used for controlling each class of plant pests in New York farm ponds, and give directions for mixing and application. The chemicals used for the different classes of plants are as follows:

Plant Pests	Chemicals
Algae (except a few)	Copper sulfate
Submersed plants and any algae not controlled by copper sulfate	Sodium arsenite
Floating plants	2,4–D
Emergent plants	Amino triazole (ATA)

Before specific directions can be given for each chemical, certain general points and procedures must be described.

Most weed killers are mixtures of the chemical that actually does the killing (called the *active ingredient)* and some other substance used to dilute it. To follow directions for controlling weeds, you must know the number of *pounds of active ingredient per gallon* of the commercial compound you are using. Be sure this information is given on the label of the product you buy. In comparing prices of various brands of a particular weed killer, the "best buy" is the one that gives you the largest amount of active ingredient per dollar. Usually more concentrated forms—that is, those having a higher percentage active ingredient—are more economical and easier to handle and measure.

Methods of controlling weeds in farm ponds are divided into two groups: (1) To kill weeds that grow beneath the water (algae and the submersed higher plants), it is necessary to produce a certain concentration of chemical in the total volume of pond water. (2) Weeds that grow on or above the water surface (floating and emergent plants) are controlled by wetting all exposed foliage with a certain strength solution of a chemical.

Dosages for the chemicals used to control algae and submersed aquatics (copper sulfate and sodium arsenite) are given in *parts per million* (abbreviated ppm) *of active ingredient by weight.* If the recommended concentration of a particular chemical is 1 ppm, this means that 1 pound of the active ingredient must be applied for every *million pounds of water* in the pond. Tables in this bulletin tell directly how much copper sulfate and sodium arsenite to use for producing the right concentration of chemical in ponds of different volumes. To use these tables you must know the amount of water in your pond.

Determining Pond Volume

If your pond was constructed with engineering assistance from a Soil Conservation Service technician or other qualified person, he may be able to tell you the volume in gallons. If not, you can determine the pond volume in acre-feet. To do this, multiply the *surface acreage* of your pond in acres by the *average depth* in feet.

There are a number of ways for determining surface acreage.

1. From calculations made when the pond was designed.

2. By comparing your pond with another pond of the same shape and size for which the surface acreage is known.

3. If your pond is rectangular (straight sides and square corners), the surface acreage equals the length in feet times the width in feet divided by 43,560. Thus, if a rectangular pond were 200 feet long on each side and 100 feet wide at each end, the surface acreage would be:

$$\frac{200 \times 100}{43{,}560} = \frac{20{,}000}{43{,}560} = 0.46 \text{ acres}$$

4. If your pond is circular, measure the total distance (in feet) around the shoreline of the pond. Multiply this number by itself, and divide by 547,390. For example, if you have a round pond and the total distance around the edge is 600 feet, then the surface acreage is:

$$\frac{600 \times 600}{547{,}390} = \frac{360{,}000}{547{,}390} = 0.66 \text{ acres}$$

This formula is for finding the area of a perfect circle, but is accurate enough for ponds which are almost round. If it is used for a pond which is oval or egg-shaped, it will give a surface acreage that is too large.

5. Areas of many ponds can be estimated from an aerial photograph or U. S. Geological Survey map. Consult a technician of your local agricultural conservation or extension agency for assistance.

6. If none of the above methods can be used, the pond may be surveyed by a fairly simple method known as plane table surveying. Technicians mentioned above, or a civil engineer, can give you help or advice on this method. The area

in square feet obtained from the survey must be divided by 43,560 to get the area in acres.

In typical farm ponds up to 1 acre in size which have rounded, uniformly sloping bottoms, the *average depth* is usually best obtained by dividing the greatest depth of water in the pond by 2. In such ponds, then:

Volume in acre-feet = surface acreage x ½ maximum depth in feet. Here is an example. A pond has a surface area of 0.3 acres, and its greatest depth is 8 feet. The volume of water in this pond is:

0.3 x 4 = 1.2 acre-feet

In ponds larger than 1 acre, and in smaller ponds which have flat or very irregular bottoms, it is best to take 15 or more depth readings *uniformly spaced throughout the pond*. The average of these readings is then multiplied by the surface acreage to obtain the acre-foot volume.

Figure 12. Broadcasting copper sulfate solution.

Table 1 is a list of measurements useful in weed control work.

Table 1. Measures of volume, weight, and area.

1 cubic foot = 7½ gallons
1 gallon = 4 quarts = 8 pints
1 quart = ¼ gallon = 2 pints = 4 cups
1 cup = 16 tablespoonfuls (tbsp.) = 8 fluid ounces
1 fluid ounce = 2 tablespoonfuls
1 tablespoonful = 3 teaspoonfuls (tsp.)
1 cubic foot of water weighs 62½ pounds
1 gallon of water weighs 8⅓ pounds
1 acre = 4,840 square yards = 43,560 square feet

Controlling Algae

Copper sulfate, also called "bluestone" and "blue vitriol," is at present the best chemical for controlling most algae in New York farm ponds.[3] This compound is sold in the form of blue crystals of various sizes. For treating ponds, crystals the size of common table salt (often called copper sulfate "snow") are easiest to use. *Unlike other chemicals discussed in this bulletin, copper sulfate is 100 per cent active ingredient; it is not diluted by addition of any other substance.*

To apply, measure out the correct amount of copper sulfate according to recommendations given below, and place it in the spray tank. Then fill the tank to the proper level with water and stir until all crystals are dissolved. The amount of water used to dissolve

[3]One common midsummer type is resistant to copper sulfate but can be controlled with sodium arsenite.

the copper sulfate makes no difference, except that the more water used, the easier it is to get even distribution of the chemical solution. Crystals will dissolve more readily in warm water, particularly if preparing solutions stronger than one-half pound of crystals per gallon. Use a sprayer with a painted, enameled, or copper lined tank, as copper sulfate solutions corrode galvanized containers.

In small ponds (one-third acre or less), the copper sulfate solution can often be well enough distributed by "broadcasting" it out into the water with a dipper as you walk along the shoreline (figure 12). *Do not use this method for any of the other weed killers mentioned in this bulletin!*

For treating ponds of more than an acre, it may be easiest to place the required weight of copper sulfate in a burlap bag and tow it behind a boat until the area to be treated has been thoroughly covered and all the copper sulfate has been dispensed.

Remember that treatment is much easier and more effective if it is made when the algae first appear on the pond bottom in shallow water. Treatment of large amounts of scum will be easiest on an afternoon following a sunny morning, when the mat is likely to be floating at the surface where it can be sprayed directly.

Different concentrations of copper sulfate are needed to control different types of algae described on pages 6 and 7.

1. Most microscopic plankton algae can be eliminated by a treatment of ¼ ppm in the few cases where their presence in the pond is undesirable.

2. Water net generally requires five successive applications of ¼ ppm, with one to two days between each.

3. Stonewort (muskgrass) can usually be controlled by a single application of 1 ppm. When large amounts of stonewort are killed with copper sulfate the water often becomes foul-smelling. This can be avoided by removing the bulk of a heavy stand by dragging before treating it with copper sulfate.

4. Control of most other algae requires ½ ppm. If two or three applications (repeated at two-week intervals) are unsuccessful, then switch to sodium arsenite (see Submersed Plants, page 26).

Table 2 gives the weight of copper sulfate to use for producing the three recommended concentrations. To use this table all you need to know is the volume of water your pond contains, either in acre-feet or in gallons. To find out how much copper sulfate to use for producing a ½ ppm concentration in a pond containing 1.0 acre-feet (326,000 gallons) of water, go down the left-hand column of the table (acre-feet) to "1.0," the volume of water in the pond. Then follow this row over to the right to where it crosses the

Table 2. Weights of copper sulfate to use for producing the three recommended concentrations.

Pond volume		Desired concentration of copper sulfate in parts per million					
Acre-feet	Gallons	¼ ppm		½ ppm		1 ppm	
		WEIGHT OF COPPER SULFATE TO USE					
		Pounds	*ounces*	*Pounds*	*ounces*	*Pounds*	*ounces*
0.1	33,000	–	1	–	2	–	5
0.2	65,000	–	2	–	4	–	8
0.3	98,000	–	3	–	7	–	13
0.4	130,000	–	4	–	9	1	1
0.5	163,000	–	6	–	11	1	6
0.6	196,000	–	7	–	13	1	10
0.7	228,000	–	8	–	15	1	13
0.8	261,000	–	9	1	1	2	3
0.9	293,000	–	10	1	4	2	6
1.0	326,000	–	11	1	6	2	10
2.0	652,000	1	6	2	12	5	5
3.0	978,000	2	1	4	1	8	1

column headed "½ ppm," and you find that 1 pound 6 ounces of copper sulfate is required. If you do not have scales available for weighing, you can determine the amount of copper sulfate by measure from table 3. Here we see that one pound six ounces can be obtained by combining one and three-quarter cups (equal to one pound) and five fluid ounces. Remember that 2 tablespoonfuls equal 1 fluid ounce (table 1). The weights given for various volumes of copper sulfate apply *only* to the finely-ground "snow" form described earlier. If larger crystals are used, they must be weighed out.

If you do not find the volume of your pond listed in table 2, you can determine the dosage by combining figures. For example, the weight of copper sulfate needed for 3.8 acre-feet is found by combining the amounts given for 3 acre-feet and 0.8 acre-feet.

Since copper has a tendency to combine with minerals in the water, more of the copper sulfate is used up this way in hard (high-mineral) waters than in soft (low-mineral) waters. For the same reason, water hardness also affects the dosage of copper sulfate safe for fish and other animals. The same concentration of copper sulfate has more

Table 3. Data for changing weights to fluid ounces and other volume measures of copper sulfate "snow."

Weight		Volume of "snow"	
Pounds	Ounces	Fluid ounces	Cups
–	1	1	
–	2	2	¼
–	3	3	
–	4	4	½
–	6	5	
–	7	6	¾
–	8	7	
–	9	8	1
–	10	9	
–	11	10	1¼
–	13	11	
–	14	12	1½
–	15	13	
1	–	14	1¾
1	1	15	
1	2	16	2 = 1 pint
1	11		3
2	4		4 = 1 quart
2	14		5
3	7		6 = 3 pints
3	–		7
4	9		8 = 2 quarts

effect on plants and animals in very soft water than it does in hard waters. Copper sulfate dosages given in this bulletin are those which are correct for moderately hard to hard waters (those having a total alkalinity of 50 parts per million or more) which are found in most New York farm ponds. Most areas of the State where softer waters prevail have very sandy or rocky soils that make farm pond construction impractical. These areas are:

(1) Southernmost portions of the Southern Tier counties, from Cattaraugus County eastward along the Pennsylvania border.

(2) Upland areas of the "Tug Hill" section, east of Lake Ontario.

(3) The Adirondack section and sandy areas bordering it.

(4) The eastern Catskills and lower Mohawk Valley.

(5) Long Island.

Owners of ponds located in areas where there is reason to suspect very soft water should either have the water tested, or start out with half the recommended dosage of copper sulfate and see if the desired results are obtained. Owners may be able to have pond water tested for total hardness by a dealer in water-softening equipment. Simple testing kits are available from some soap and detergent companies.

Submersed Plants

Sodium arsenite is used to destroy submersed plants as well as filamentous algae resistant to copper sulfate. A concentration of 4 ppm is usually adequate. Sodium arsenite as used for water weed control is a liquid, heavier than water.

Sodium arsenite is a *dangerous poison* to all warm-blooded animals. The poison can be absorbed through the skin as well as the digestive tract. Furthermore, sodium arsenite solution is caustic and can burn the skin or clothing if not washed off promptly. Safety precautions were described in a preceding section (pages 18–19); observe them with great care and follow all handling instructions given by the manufacturer. Wear rubber gloves and make sure to wash immediately any clothing or skin coming in contact with the chemical. If all precautions are carefully followed, sodium arsenite is entirely safe to use, and is one of the most useful weed killers.

Some investigators have reported that a 4 ppm concentration of sodium arsenite has reduced crayfish populations. Although such observations have not been reported from New York, owners of crayfish ponds might do well to use caution in employing this chemical. In crayfish ponds, however, submersed plants are generally beneficial, and the only possible need for weed control would be to permit easier netting of the crayfish for sale. The concentrations recommended here are well within the margin of safety for fish.

Table 4 gives the amount of sodium arsenite solution—as it comes from the can—to use in farm ponds of different volumes. Dosages are given for the two types of sodium arsenite solution generally available—4 and 9½ pounds active ingredient per gallon. In this table, all quantities to be used are given in quarts, but these can be easily changed to other units of measure such as cups, gallons, etc., with the aid of table 1 (page 22). If your pond volume does not appear in table 4, it is easy to get the correct sodium arsenite dosage by combining figures, just as was explained on page 24 for using the copper sulfate table.

To apply sodium arsenite, pour the required amount (or a portion of it) into the sprayer tank, fill the

Table 4. Quarts of liquid sodium arsenite to use in ponds of different volumes. Amounts are shown for commercial products of two strengths.

Pond volume		Pounds active ingredient per gallon of commercial product	
Acre-feet	Gallons	4	9.5
		QUARTS COMMERCIAL PRODUCT TO USE	
0.1	33,000	1⅛	½
0.2	65,000	2¼	⅞
0.3	98,000	3¼	1⅜
0.4	130,000	4⅜	1⅞
0.5	163,000	5½	2¼
0.6	196,000	6½	2¾
.0.7	228,000	7½	3¼
0.8	261,000	8¾	3¾
0.9	293,000	9¾	4¼
1.0	326,000	10¾	4½
2.0	652,000	21¾	9¼
3.0	978,000	32½	13¾

tank to the desired level with water, and spray, being careful to observe all safety precautions. Here again, the amount of water used is not important. Sodium arsenite solution is heavy and may not spread throughout the pond. Regulate your spraying so that all the solution is evenly distributed over the areas where weeds are present or suspected.

Sodium arsenite is slow-acting, and its effects on the plants may not become noticeable until a week after spraying.

Floating Plants

In farm ponds the most effective chemical for controlling floating plants is 2,4–D. This compound is available in many forms, but the ester form (a liquid) should be used. To minimize the danger to land plants in nearby areas, it is preferable to use a *low-volatile* ester of 2,4–D. Do not confuse this chemical with DDT (poisonous to fish and insect life) or 2,4,5–T.

A very small amount of the 2,4–D ester is added to no. 2 fuel oil to make a spray containing 0.25 per cent active ingredient by weight. The mixture is sprayed directly on the weeds, and *only* on the weeds. Here the object is to thoroughly wet all exposed leaves with a coating of the solution, so the important thing is to mix a spray of the right strength. The amount of solu-

Table 5. Quantities of 2,4-D ester to mix with fuel oil for controlling floating weeds. Amounts are shown for commercial products of six different strengths.

Concentration of commercial product in pounds acid equivalent 2,4-D per gallon	Gallons of fuel oil				
	1 gal.	3 gal.	5 gal.	10 gal.	100 gal.
Lbs. per gal.	AMOUNT COMMERCIAL PRODUCT TO USE				
1	4 tbsp.	¾ cup	1½ cups	3 cups	7 qts.
2	2 tbsp.	7 tbsp.	¾ cup	1½ cups	3½ qts.
3	5 tsp.	5 tbsp.	½ cup	1 cup	2½ qts.
4	1 tbsp.	10 tsp.	6 tbsp.	¾ cup	1¾ qts.
5	1 tbsp.	8 tsp.	5 tbsp.	10 tbsp.	1½ qts.
6	2 tsp.	7 tsp.	4 tbsp.	½ cup	1¼ qts.

tion required will depend on the amount of weeds present.

In liquid 2,4–D products, concentration is expressed in "pounds acid equivalent of 2,4–D per gallon." Table 5 gives mixing proportions for products of six different commercial concentrations. In each case, strength of the spray solution produced is the same. If you wish to make 3 gallons of spray solution, and your 2,4–D ester has a concentration of 4 pounds acid equivalent per gallon, table 5 shows that you should mix 10 teaspoonfuls of this ester with 3 gallons of fuel oil.

The upper row of table 6 tells about how much 2,4–D spray solution will be needed for treating various areas of floating weeds. If there are fish in the pond, it is best not to use more than 100 gallons of spray per acre of pond surface.

Reports from other states indicate that 2,4–D or the fuel oil carrier may give a poor flavor to pond fish for several weeks after treatment. Probably the amount that fish flavor is affected depends partly on how much of the pond is treated.

Until recently it was thought that sprayers which contained 2,4–D could be safely used for spraying plants other than weeds if the sprayer were first thoroughly cleaned with a compound such as ammonia or trisodium phosphate. Recent research has demonstrated that this is not the case.[4] *A sprayer which has been used with 2,4–D is hazardous to some plants even after thorough cleaning.*

Emergent Plants

In New York farm ponds, the chemical recommended for treating emergents—of which cattail is the chief pest—is amino triazole, abbreviated ATA. Amino triazole is a newer herbicide than 2,4–D, but is now quite generally available in

[4]For more information on this, write to: New York State Experiment Station, Geneva, New York

Table 6. Guide to approximate gallons of spray solution needed for treating different areas of floating and emergent plants.

Type of plant and spray	Area covered by plants										
	Square feet							Acres			
	100	200	300	400	500	1,000	2,000	¼	½	¾	1
	GALLONS OF SPRAY SOLUTION REQUIRED										
Floating (2,4-D)	¼	¼	⅝	⅞	1⅛	2¼	4½	25	50	75	100
Emergent (ATA)	½	1	1¼	1¾	2¼	4½	9	50	100	150	200

garden and farm supply stores in the form of a wettable powder. Most of the ATA marketed contains 50 per cent active ingredient by weight. Table 7 gives amounts of this product to mix with various quantities of *water* to produce a spray solution of the proper strength for treating cattails and other emergent plants.

The objective is to thoroughly wet all exposed parts of the plants. The bottom row of table 6 provides information on the approximate amounts of ATA spray solution required to treat various areas of emergent plant growth.

For good control of cattails, proper timing of the ATA treatment is important. These plants should be sprayed some time during the interval when they are in flower or after the seed "heads" have appeared, but while the heads are still green. This period usually lasts about 6 to 8 weeks.

Table 7. Amounts of amino triazole (ATA) to mix with different amounts of water for controlling emergent weeds. *Figures given are for the commercial product that contains 50 per cent active ingredient.*

	Gallons of water						
	1 gal.	**3 gal.**	**5 gal.**	**10 gal.**	**50 gal.**	**100 gal.**	**200 gal.**
	AMOUNT OF DRY ATA TO USE						
Weight	1 oz.	2 oz.	¼ lb.	½ lb.	2½ lbs.	5 lbs.	10 lbs.
Equivalent in level measure	3 tbsp.	½ cup	1 cup	1¼ cups	2 qts.	1 gal.	2 gals.

Summary of Chemical Treatments

Algae

Dissolve correct amount of *copper sulfate* in *water* and spray over all parts of pond where growth is seen or suspected.

Amount—Table 2, page 24, gives quantity to use for producing desired concentration of copper sulfate in the pond water.

Concentrations needed to kill different kinds of algae:

Plankton (water bloom)—¼ ppm.

Water net—five applications of ¼ ppm, with one to two days between each.

Stonewort (muskgrass)—1 ppm.

Most filamentous (mat-forming) algae—½ ppm.

Summersed Plants and filamentous algae resistant to copper sulfate.

Mix correct amount of *sodium arsenite* solution with *water* and spray over all parts of pond where weed growth is seen or suspected.

Amount to use given in *table 4,* page 27.

Floating Plants

Mix correct amount of *2,4–D low-volatile ester* with *fuel oil.* Use moderately coarse spray to wet down all exposed leaves. Spray only those areas where floating leaves are present.

Proportions for mixing spray of correct strength given in *table 5,* page 28.

Quantity of spray needed for different areas of weeds—*table 6,* page 29.

Emergent Plants

Mix correct amount of *amino triazole* (50% active) with *water.* Use sprayer to wet down all plant parts exposed above water.

Proportions for mixing spray of correct strength given in *table 7,* page 29.

Quantity of spray needed for different areas of weeds—*table 6,* page 29.

Points to Remember

1. *Read all directions carefully. This summary* does not contain all the information needed to destroy weeds safely and effectively.
2. Know what type of weed you're working with.
3. Know the State laws that apply in your case.
4. Use the recommended dosage, treat only when weeds are present, and wait at least two weeks between treatments.
5. Observe precautions given in this bulletin and on the label of the product you buy.

Legal Responsibilities

Section 180 of the Conservation Law prohibits causing the entry of poisonous substances into any waters, private or public, in quantities injurious to fish life or propagation of fish therein.

Further, under a new ruling of the State Water Pollution Control Board that became effective April 1, 1958, *a permit may be required for use of chemicals for controlling aquatic vegetation.* The complete text of this ruling follows:

> No person, including a municipality, individual, firm, corporation, association, organization, or institution, shall use chemicals for the control or elimination of aquatic vegetation in any waters of the state without a written permit to do so from the permit issuing official. **Such permit, however, shall not be required for the use of chemicals for that purpose by a duly constituted water supply agency in water-supply waters, nor for treatment for weed control of ponds or lakes having no regularly flowing outlet to other waters and which lie wholly within the boundaries of lands owned or leased by the person making or authorizing such treatment.** The board hereby designates the health commissioner of a city, county, or part-county health district or the state district health officer as permit issuing officials. Such permit issuing officials are hereby empowered, subject to such limitations as the board shall prescribe, to issue such permits in the name of the board in their respective areas of jurisdiction when the use of chemicals for such purpose shall not be deemed to cause a condition of the waters of the state which is deleterious, harmful, detrimental or injurious to the public health, safety or welfare, to terrestrial or aquatic life or growth and propagation thereof other than aquatic vegetation, or to any of the present usages of such waters or waters to which they are tributary for domestic, commercial, industrial, agricultural, recreational or other reasonable purposes. Any person aggrieved by the denial of a permit may protest such denial within thirty days thereafter to the board by filing a verified protest in writing with the board showing the grounds and facts entitling him to the grant of such permit.

For assistance in determining whether a permit is required in your situation or to make application for a permit, contact your county health commissioner or State district health officer. Your county agricultural agent can help you make this contact.

Other Cornell Publications on Farm Ponds

Farm Ponds in New York. By Carl S. Winkelblech. Cornell Extension Bulletin 949. December 1955.

Raising Bait Fish and Crayfish in New York Ponds. By J. L. Forney. Cornell Extension Bulletin 986. September 1957.

Fish Pond Management Outline. Wildlife Mimeo No. 1, Cornell University Department of Conservation.

Bait Fish Culture—A Partial List of References. Wildlife Mimeo No. 2, Cornell University Department of Conservation.

A Partial List of Brood Stock Sources for Bait Minnow Ponds. Wildlife Mimeo No. 6, Cornell University Department of Conservation.

A Suggested Procedure for Reclaiming Farm Fish Ponds. Wildlife Mimeo No. 9, Cornell University Department of Conservation.

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